



Winter Ecology

6th-12th Grade Field Trip **Preparing For Your Trip**





Welcome and Need to Know Information

Dear Teacher,

This packet contains all the information you will need to prepare your students for a winter field trip to Glacier National Park.

- The field trip lesson plan on pages 15-20 should answer most questions about field trip logistics, objectives, and schedules.
- The rest of the lessons are meant to prepare students for the concepts and vocabulary highlighted on the field trip. Each activity can serve as a pre-visit introduction or a post-visit assessment/extension. A suggested unit plan organization is located on the following page.
- Glacier's [SmartBoard lessons](#) are a great way to supplement this unit. Learn about the importance of Glacier's snowpack, how to dress for winter, and lots more!
- Visit our [website](#) for more lesson plan ideas and background information for any field trip. This guide contains only a sample of what is available.

Be sure to confirm the date(s) and meeting place for your field trip (received via e-mail is/are correct). There is no cost for this field trip. A waiver for the park entrance fee has been processed for your class(es). [Travel grants](#) may be available to schools with restricted travel budgets.

The education ranger assigned to your group will call you before your field trip date to discuss the schedule and answer any questions. You can also reach them at 406-888-7899.

Our winter education programs are made possible by the support of the Glacier National Park Conservancy. Thank you for introducing your students to the National Park Service Mission and the wonders of Glacier!

Glacier National Park
Education Staff



Glacier National Park
CONSERVANCY

Glacier's Education Goals

- Provide opportunities for the students to form emotional and intellectual connections with park resources and values.
- Introduce students to the National Park Service mission and the significance of Glacier National Park.
- Provide curriculum-based, outdoor education experiences that are age appropriate and supplement classroom learning objectives.
- Introduce students to the value of protecting natural and cultural resources for current and future generations and to encourage actions we can all take to be good stewards of this special place.



	Summary	Objectives <i>Students will be able to:</i>	MT State Standards and Next Generation Science Standards	Materials
Pre-Field Trip <i>Locating Glacier National Park</i>	Students label maps to locate and identify landmarks near Glacier National Park in different geographic areas: Glacier National Park and surroundings; the Pacific Northwest and Western Canada; and North America.	<ul style="list-style-type: none"> Identify Glacier's location relative to different landmarks Explain Glacier's location in relation to the Pacific Northwest and North America. Relate that Glacier's water ultimately flows into major watersheds. 	MT.SS.K-12.12.3...Apply geographic knowledge and skills...interpret, use, and synthesize information from various representations of the Earth.	<ul style="list-style-type: none"> Map handouts (Glacier NP, Pacific Northwest and Western Canada, North America) List of landmarks Colored pencils
Pre-Field Trip <i>How Much Water is in this Snow?</i>	Students collect snow samples to calculate how much water is in the snow then discuss how to calculate "snow water equivalent (SWE)" to forecast our annual water supply.	<ul style="list-style-type: none"> Calculate snow density and know how it is used to find snow water equivalent (SWE) for water supply forecasts. Explain why mountain snowpack is important to our water supply. Discuss how mountain snowpack in Glacier is a resource for everyone in the United States. 	<p>MT.SCI.K-12.9-12.1... Design, conduct, evaluate, and communicate results and reasonable conclusions of scientific investigations.</p> <p>HS-ESS3-1. Construct an explanation based on evidence for how the availability of natural resources...has influenced human activity.</p>	<ul style="list-style-type: none"> Colored pencils Locating Glacier National Park map Container of known volume Snow
Field Trip <i>Winter Ecology in Glacier</i>	Students examine the winter environment and its effects on plants, animals, and people by going on a snowshoe hike.	Vary depending on field trip. Talk to the ranger before your visit for more information.	<p>MT.SCI.K-12.3...Knowledge of characteristics, structures, functions of living things...and how living organisms interact with each other and their environment.</p> <p>MS-LS2-2. Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.</p>	<ul style="list-style-type: none"> Warm clothes Name tag Lunch Adult helpers
Post-Field Trip <i>Snow as Our Drinking Water Webquest</i>	Students complete a Webquest integrating science and technology and using online resources and field trip data to answer questions about the quantity and quality of water in their area.	<ul style="list-style-type: none"> Answer questions about water availability and quality. Synthesize data collected in Glacier and other scientific data to answer questions about snow water equivalent and its importance to human society. 	<p>MT.SCI.9-12.4... Knowledge of the composition, structures, processes and interactions of Earth's systems and other objects in space....</p> <p>HS-ESS3-1. Construct an explanation based on evidence for how the availability of natural resources...has influenced human activity.</p>	<ul style="list-style-type: none"> Webquest outline Computers with Internet connection Data sheets from Glacier National Park



Lesson 1: Pre-Visit

Locating Glacier National Park

Materials:

- * Map handouts (Glacier National Park, Pacific Northwest and Western Canada, North America)
- * List of landmarks
- * Colored pencils



Vocabulary

Continental Divide, national forest, national park, indian reservation, International Peace Park, triple divide, watershed.

Method

Students will label three maps to locate and identify landmarks near Glacier National Park in ever greater geographic areas: Glacier National Park and surroundings; the Pacific Northwest and Western Canada; and North America.

Objectives

Students will be able to:

- Locate Glacier National Park and other landmarks within Montana in relation to: the Continental Divide; Waterton Lakes National Park; Alberta and British Columbia; the three divides: Pacific, Hudson Bay and Gulf of Mexico; and the students' community.
- Locate Glacier and Montana in relation to the Pacific Northwest and in relation to North America.
- Identify the bodies of water that Glacier's waters ultimately flow into.

MT State Social Studies Standard

MT.SS.K-12.12.3 Students apply geographic knowledge and skills (e.g., location, place, human/environment interactions, movement, and regions).

- A proficient student will interpret, use, and synthesize information from various representations of the Earth.

MS-ESS3-3 Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.

- Humans depend on Earth's land, ocean, atmosphere, ... for many different resources. Minerals, fresh water, and biosphere resources are limited, and many are not renewable or replaceable over human lifetimes. (MS-ESS3-1)

Background

Even before Glacier National Park was established in 1910, it was an important cultural and economic contributor to the state of Montana. The scenery of the area attracted visitors, mostly by train, well before the park was established. The Great Northern Railroad (now Burlington Northern Santa Fe) still runs along the park's southern border and Amtrak still carries visitors to and from the area.

Background

For Native Americans whose homelands encompassed Glacier, the area has great spiritual significance. The Blackfeet refer to the mountains here as the “Backbone of the World.” The Kootenai translation for the Lake McDonald area refers to it as “the place to dance.” Today, the Blackfeet Reservation shares Glacier’s eastern border. The Kootenai, Salish, and Pend d’Oreille are part of the Flathead Reservation south of Glacier.

Glacier National Park straddles the Continental Divide. The divide defines watersheds. West of the divide water flows to the Pacific Ocean and east of the divide water flows to the Gulf of Mexico or Hudson Bay. Because water from the park flows in three different directions, Glacier contains a rare geologic feature—a triple divide. Water from Glacier passes through many different places on its way east or west. The people and animals living around Glacier depend on this water. For instance, Lake McDonald eventually flows into Flathead Lake via the Flathead River. Along the way that water passes through Columbia Falls and Kalispell.

The Flathead National Forest shares Glacier’s western and southern boundaries. The Blackfeet Indian Reservation shares the eastern boundary. North are the Canadian provinces of Alberta and British Columbia. Waterton Lakes National Park is Glacier’s sister park in Alberta, Canada. The two parks merged in 1932, becoming the world’s first International Peace Park.

Procedure

1. Using a globe or North American map, introduce students to the location of Montana in the United States and in North America. Point out the location of various landmarks - Rocky Mountains, Canadian Border, the Pacific Ocean, Gulf of Mexico, and Hudson Bay, the plains of Eastern Montana.
2. Then, using an interactive whiteboard or a document camera, show the maps of the United States and North America. See if together as a class, you can locate and label those same landmarks.
3. Discuss the location of the students’ hometown on the map of Glacier and vicinity. Also discuss the location of various protected lands within Montana - national forests, national parks. Point out the Flathead and Blackfeet Indian Reservations, the three watersheds, and major rivers.
4. Distribute a copy of the three maps to each student. Decide in advance which things on each map you want them to be able to label. On the North American map they can label the oceans, countries, and state of Montana. On the Pacific Northwest map, they could label the Canadian provinces, American states, and the ocean. On the Glacier map, they could label their home town, the rivers, the lakes, and the three watersheds.

Evaluation

Discuss the importance of the geographic location of Glacier National Park. Have students hypothesize as to why certain types of plants and plant communities live in the park. What about the different animal species that live in Glacier?

Extension

On a road map have students trace the route from their school to Glacier National Park. Have them do the same for other landmarks on the map as well. Visit the park’s [Teacher Cultural Resource Guide](#) to learn more about people and the area now known as Glacier National Park.

Name: _____

Date: _____

Locating Glacier National Park in North America



Name: _____

Date: _____

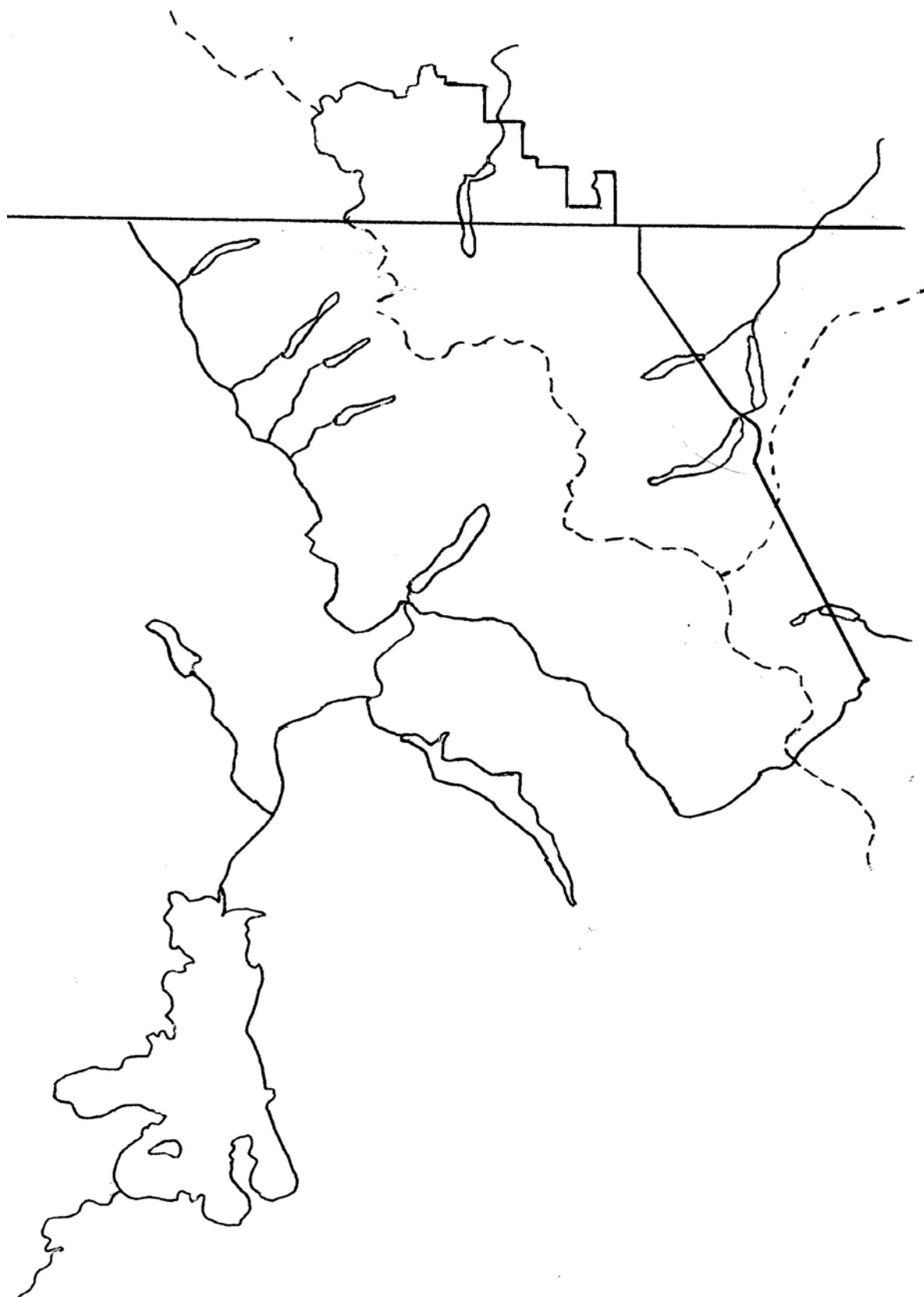
Locating Glacier National Park in the Pacific Northwest



Name: _____

Date: _____

Locating Glacier National Park in Northwest Montana





Lesson 2: Pre-Visit

How Much Water is in this Snow?

Materials:

- * Locating Glacier NP map
- * Container of known volume
- * Snow



Vocabulary

Snow survey, density, mass, volume, snow water equivalent (SWE), watershed.

Method

Students collect snow samples to calculate how much water is in the snow then discuss how to calculate “snow water equivalent (SWE)” to forecast our annual water supply.

Objectives

Students will be able to:

- Calculate snow density and understand how that is used to find the snow water equivalent (SWE) for water supply forecasts.
- Explain why mountain snowpack is important to our water supply.
- Relate how the mountain snowpack in Glacier is a resource for everyone in the United States.

MT State Science Standard

MT.SCI.K-12.9-12.1 Students, through the inquiry process, demonstrate the ability to design, conduct, evaluate, and communicate results and reasonable conclusions of scientific investigations.

- A proficient student will Select and use appropriate tools including technology to make measurements (in metric units), gather, process and analyze data from scientific investigations using appropriate mathematical analysis, error analysis, and graphical representation

Next Generation Science Standard

HS-ESS3-1. Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.

- Resource availability has guided the development of human society. (HS-ESS3-1)

Background

Glacier National Park works with the Natural Resource Conservation Service (NRCS) to collect data on mountain snowpack. The NRCS is a federal agency that provides information to help people to be good stewards of the nation’s soil, water, and related natural resources on non-federal lands.

Background

The NRCS continuously monitors mountain snowpack and climate. They use data gathered from manual surveys conducted by park rangers and other trained personnel along with automated information from the SNOTEL (SNOWpack TELemetry) network to forecast water supplies. Major sectors of the economy — agriculture, industry, recreation, and government — base their water management plans on NRCS water supply forecasts, climate products, and drought risk assessments. NRCS snow surveyors measure mountain snowpack and forecast seasonal runoff in streams and rivers. This information is used to make sound water management decisions. Glacier National Park contains the head waters for three major watersheds in North America that meet at Triple Divide Peak. The Columbia River Drainage, the Missouri River Drainage, and the Hudson Bay Drainage. The [NRCS website](#) has excellent and extensive information about conducting snow surveys as well as the current water supply forecasts. In addition, the [NRCS Agricultural Information Site Bulletin 536](#) has a clear explanation of the importance of mountain snow to water forecasting and the steps for conducting snow surveys.

Procedure

1. Tell students that they will be following similar procedures and calculations that rangers and NRCS personnel use to measure how much water is in a snowpack.
2. Discuss why it's important to know this and who it affects.
3. Show students the map, "Locating Glacier National Park in Northwest Montana." If you haven't labelled these maps in the Locating Glacier lesson, work together to label: their hometown, the rivers, the lakes, and the three watersheds.
4. Make sure students understand the significance of having the headwaters of these three large watersheds for North America fall within Glacier National Park. Why would a community, or a nation, decide to keep the watershed headwaters undeveloped and in a protected area?
5. Once students understand the significance of the watersheds, challenge them to think about how mountain snowpack in Glacier National Park contributes to those watersheds. You may even want to visit the SNOTEL website to see how much snow there is in Glacier right now. Compare the snow depths and weather observations with where you live. Students may be amazed at the difference!
6. After students realize the importance of mountain snowpack as a water resource, it's time to calculate how much water is in the snow.
7. To be able to calculate the density of the snow, students must first understand what density represents. Students will need to use a container of known volume to get a snow sample, and then find out the mass of the snow. A 1000 cc container makes the calculations really simple but if none are available, making students calculate the volume of a cylinder like a baby food jar or empty tin can adds an additional math challenge.
8. Use the "How Much Water is in this Snow?" worksheet on page 14 to walk students through the steps of calculating snow density and percent density.
9. Freshly fallen snow ranges from about 5% to about 20% water, depending

Procedure, Continued

on the air temperature and humidity in the atmosphere. After the snow falls its density increases due to gravitational settling, wind packing, melting, and recrystallization.

10. To accurately calculate snow water equivalent (SWE) students need to know not only the density of the snow, but how deep the snow OF THAT SAME DENSITY is. This can be tricky since once snow hits the ground, its density is constantly changing. NRCS staff have a special snow tube which collects snow from an entire snow column, surface all the way to the ground. Check it out [here](#). Multiple samples are taken along a snow survey course and each course is surveyed multiple times on a regular schedule throughout the winter.

Evaluation

Compare the students' measurements and calculations for snow density. Were they all the same? Different? Why or why not? Can students correctly label the three watersheds that meet in Glacier National Park and give one reason mountain snowpack is important to people living within those watersheds? Challenge students to think about what would happen if the precipitation at Glacier National Park did not fall as snow, but as rain. How would that affect our water supply (even if it were the same amount of precipitation)?

Extension

Have students calculate how much water they use per day and compare it with the average per capita use for United States residents. Then compare the average U.S. per capita water use with other countries. The snow that accumulates in Glacier National Park throughout the winter is an extremely valuable source of water for people and animals. When the snow melts, it flows down through the streams to the lakes and replenishes the water supplies that we all depend on. What are some things we can all do to help ensure that we have enough clean, fresh water?

Name: _____

Date: _____

How Much Water is in this Snow?

1. Mass of snow sample container empty = _____
2. Mass of snow sample container with snow = _____
3. Subtract line 1 from line 2 to get the mass of just the snow = _____
4. Volume of your snow sample container (get the volume from your teacher or calculate it yourself with the formula your teacher provides) = _____
5. Find Snow Density using the following equation: $\text{Snow Mass (\#3)} \div \text{Volume of Container (\#4)} = \text{Snow Density}$
6. $\text{Snow Density (\#5)} \times 100 = \text{Percent of water in your snow sample.}$
7. Compare your answer for snow density to other students' results. Did everyone get the same snow density? Why or why not? Where in the snowpack does the snow seem to be the most dense (top, middle, or bottom)? Do you think you would get the same results tomorrow?
8. Water supply forecasters use snow density to calculate what the depth of water would be if all the snow melted right now. They call this the snow water equivalent or SWE). To get SWE, the snow density (not the percent) must be multiplied by the depth of the snow. Can you calculate SWE for your snowpack? What would you have to do to make it accurate?



Lesson 4: Field Trip

Winter Ecology in Glacier

Remember:

Flexibility is essential for an enjoyable visit to Glacier. Each program is unique but the following represents a typical visit.



Vocabulary

Varies by field trip but may include: national parks, preserve, protect, sun, earth, heat, energy, seasons, winter, snow water equivalent, water cycle, weather, climate, temperature, adaptation, migration, hibernation, resistance, food chain, subnivean, predator, prey, camouflage, insulation, snowpack, habitats.

Method

Students will examine the inter-relationships between living and non-living components of the winter environment by exploring the physical properties of snow. They will dig snow pits and collect data from their snow samples. They will investigate how those physical properties impact organisms in winter (including people) during a one to two-hour snowshoe hike.

Objectives

Students will be able to (depending on grade level and weather condition):

- Describe the National Park Service Mission and why Glacier was established.
- Identify the 3 major watersheds that Glacier contains the headwaters for.
- Use a map to locate Glacier, the Continental Divide, and other significant features surrounding the park.
- Assemble a puzzle-map of the Crown of the Continent Ecosystem and explain why it is important that neighbors work together toward shared goals.
- Record a variety of temperatures (air, snow), compare/contrast them and discuss temperature's relationship to heat and energy.
- Explain how the abiotic and biotic components of the winter environment are inter-related.
- Communicate why the continuously changing state of water (between solid, liquid, and gas) can be helpful as well as harmful to winter organisms.
- Recognize track patterns and record wildlife signs/sightings.
- Name at least 2 factors that make winter a challenge for living organisms to survive and give 2 examples of adaptations to cope with these factors.
- Give an example of how cells and cellular processes (photosynthesis,

Objectives, Continued

respiration) continue in living things when temperatures are below freezing.

- Dig a snow pit, collect snow cores, calculate density and snow water equivalent for each sample, and analyze the results.
- Tell why measuring and monitoring snow water equivalent is important to people living in the watersheds originating in Glacier National Park.
- Observe and classify snowflake shapes. Explain the importance of snow as a natural resource and its role in the water cycle.

MT State Science Standards

MT.SCI.K-12.1 Students, through the inquiry process, demonstrate the ability to design, conduct, evaluate, and communicate results and reasonable conclusions of scientific investigations.

MT.SCI.K-12.3 Students, through the inquiry process, demonstrate knowledge of characteristics, structures, functions of living things...and how living organisms interact with each other and their environment.

Next Generation Science Standards

MS-LS2-2. Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.

HS-ESS3-1. Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.

While these standards are the most applicable for what we highlight during an education program, there are many other standards that may also apply.

Background

Glacier National Park protects habitat and natural processes with little human disturbance. In winter, this habitat changes drastically. Winter ecologists study the inter-relationships and adaptations of organisms that allow them to cope with these changes and for some organisms, even allows them to thrive during winter.

Sample Field Trip Schedule

8:30 am – 9:30 am. Travel to the Park

Simple assignments can be completed by seat-mates during this time. Point out sights along the way that relate to the park story such as glacially carved valleys, plant communities, winter changes, river crossings. You may also want to review vocabulary words or ecological concepts.

9:30 am – 10:00 am Meet Park Rangers at Designated Site

After a welcome by park rangers to Glacier National Park, the group will talk about the National Park Mission, take a snack/bathroom break, and get snowshoes.

10:00 am – 1:00 p.m. Snowshoe and Winter Pack Activities.

Rangers will use the resources along the trails to involve students in learning about winter signs, winter stress factors and adaptations for coping with winter, as well as snowpack characteristics, and vegetation types.

1:30 p.m. – 2:00 p.m. Concluding Activities and Return Equipment

Ranger(s) review the educational objectives for the day. Snow shoes are returned and students' inventory winter packs.

Lunch – Can be eaten while on the trail or the group may do lunch on their way to or from the park depending on time.

2:00 p.m. – Bus Leaves the Park

Protecting the National Park

In order to have a fun and exciting experience, a firm framework of rules should be discussed in advance. The discussion should include the following points:

- Respect both plants and animals in Glacier National Park.
- Harassing animals and picking flowers, pine cones, feathers, and other natural objects in the park are illegal.
- Respecting rights of others in Glacier by refraining from disruptive behavior.
- Respecting each other, the ranger, chaperones, and teachers (walk on trails, keep hands to yourself, wait to talk until the instructor is finished, etc.).

School Regulations and Safety

Teachers are responsible for following school regulations regarding parental permission slips, travel authorization/insurance, etc. An accident can ruin a field trip and jeopardize future ones. Safety is of utmost importance. Students must be with adults at all times.



Clothing

Remind students to check the weather and bring appropriate, comfortable clothing, including a hat, snow pants, winter coat, gloves/mittens, and boots. Encourage students to bring extra layers and dry clothes.

Name tags

For safety and courtesy, rangers prefer to call students by name. Masking tape with names written in big letters, works well. If name tags are made as a pre-visit activity, be sure they are easy to read and stay on when students are active.

Food and Lunches

Everyone needs a lunch and drink. Re-sealable drinks work best as they can be refilled and saved. No food or drink is available at the park. Students are expected to clean up the lunch area. Food/gum are prohibited except at designated times.

Groups

See the chaperone guidelines on the next page. Typically it works best to assign adults to groups of students before arriving at the park. (A typical bus of 45 students would be divided into nine groups of five students each.)

Items to leave Behind

Students should not bring iPods, CD players, radios, cell phones, or money. These items can be lost and may be a distraction. Adults should leave cell phones at home (or turned off) during the field trip. Cameras and binoculars will not be needed and may only be brought if they will be used at ranger approved times. Designating an adult as the class photographer and asking them to take pictures throughout the day to share with everyone is a great alternative.

Winter Weather and Road Conditions

Check [road conditions](#) and [weather conditions](#) the morning of your program. [Webcams](#) can show you and your students the weather in Glacier in real time. Call the Education Staff (406-888-7899) with questions. Programs may be cancelled if the day's high temperature, with wind chill, is to be 10°F or below. Sometimes modified programs are an option. Talk with your rangers to find out more.

Chaperone Guidelines and Responsibilities

The chaperone requirements for ranger-led educational field trips to Glacier are (these numbers include the teacher):

- Kindergarten - 2nd Grade = 1 adult for every 3 students (example: 22 students, 8 adults required/allowed).
- 3rd - 5th grade = 1 adult for every 5 students (example: 22 students, 5 adults required/allowed).
- 6th grade and higher = 1 adult for every 10 students (example: 22 students, 3 adults required/allowed).

Please assist your child's teacher by volunteering to help with a field trip to Glacier, or by respecting their apologies when your help is not needed because it exceeds the park's guidelines listed above. Our facilities, staffing, and resource protection mandate that we limit not only the number of students we can handle per trip, but also the number of adults with each group.

If you are selected to help with a field trip, realize that you are an important partner in our program. We need your participation and cooperation to make the trip a success and will be asking this of you:



- **Do not bring siblings** who are not part of the class. Your full attention is needed to help monitor the students assigned to you that day.
- **Please ride on the school bus.** It makes getting everyone through the entrance station much easier and avoids parking problems.
- **Assist with safety.** It will be one of your primary duties as a chaperone.
- **Be an active participant.** Students will want to participate if you do.
- Provide guidance to students for lunch and clean-up.
- Help set boundaries and provide leadership.
- Guide the learning process and help focus students on the activity or speaker.
- **Please consult with your school administrators about the policy regarding firearms on school sponsored events.** We have never had an injury from a wildlife encounter in over 20 years of conducting school field trips in Glacier. Rangers carry bear spray, first aid kits, and radios and will show the group how to hike and recreate safely while in the park.
- **Most importantly** go with the flow, adapt, and have fun in Glacier! The students pick up on how you react if you are having fun, they will too!

Sample Evaluation of Ranger



IN REPLY REFER TO:

United States Department of the Interior

NATIONAL PARK SERVICE
Glacier National Park
West Glacier, Montana 59936

Dear Teacher:

Thank you for participating in the education program at Glacier National Park. We hope that the field trip provided your class with an opportunity to better understand the significance of their national park. To help us better prepare for your next visit, please take a few minutes to complete this evaluation of our program. We greatly appreciate your thoughts and comments.

Date of Field Trip: _____

Please let us know how your field trip went with a short comment for each of the items below.

Name of Ranger(s): _____	# Rating
Rangers' behavior and responsiveness to students, teachers, and chaperones was appropriate.	
The ranger-led program was presented in a clear and appealing manner at an appropriate level for the students.	
The rangers showed concern for the safety of the participants.	
Rangers were adequately prepared.	
Program registration and pre-program information/contact was sufficient.	

Additional comments about the program, ranger(s), or pre-visit information:

Sample Evaluation of Teacher



United States Department of the Interior

NATIONAL PARK SERVICE
Glacier National Park
West Glacier, Montana 59936

Dear _____:

Thank you for participating in the education program at Glacier National Park on _____.

We hope that the field trip provided your class with an opportunity to better understand the significance of their national park. As a follow-up we are sending all participating teachers this evaluation to help you better prepare for your next trip. This evaluation is intended to point out strengths as well as areas that need additional attention.

Students wore name tags and were properly dressed for the day.	
Snacks/lunches were organized for easy distribution and everyone assisted with lunch clean-up.	
There were an appropriate number of chaperones present.	
Chaperone(s) actively participated in supervising students.	
Pre-site class preparation was evident.	
Class behavior facilitated a positive learning environment.	

Additional comments:

Sincerely,

Park Ranger(s)



Lesson 4: Post-Visit

Snow as Our Drinking Water Webquest

Materials:

- * WebQuest outline
- * Computers with Internet connection
- * Data sheets from Glacier National Park



Vocabulary

Drought, water quality, snow water equivalent.

Method

Students complete a WebQuest integrating science and technology and using online resources and field trip data to answer questions about the quantity and quality of water in their area.

Objectives

Students will be able to:

- Analyze information from multiple sources to answer questions about water availability and quality
- Synthesize data collected in Glacier and other scientific data to answer questions about snow water equivalent and its importance to human society.

MT State Science Standard

MT.SCI.9-12.4 Students, through the inquiry process, demonstrate knowledge of the composition, structures, processes and interactions of Earth's systems and other objects in space.

- Collect and analyze local and regional weather data to make inferences and predictions about weather patterns; explain factors influencing global weather patterns and climate; and describe the impact on earth of fluctuations in weather and climate

Next Generation Science Standard

HS-ESS3-1. Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.

- Resource availability has guided the development of human society. (HS-ESS3-1).

Background

Humans depend on Earth's natural resources, including water, to survive. Monitoring and managing the supply of these resources is critical. There is a wealth of information collected by scientists that individuals and communities can be uses to better manage resources. Data and information

Background, Continued

collected and transmitted by SNOTEL stations and from manual collection sites are used by many governmental and private entities. This information influences production decisions on millions of acres of surface-water dependent, irrigated agricultural lands. Knowing how much water is available in the water supply (and the relative seniority of their water rights) helps producers make cropping decisions about what, when, and how much to plant to optimize their production outcome.

The health of our nation's waters depends on the vast network of streams and wetlands where they begin. These streams feed downstream waters, trap floodwaters, recharge groundwater supplies, remove pollution, and provide fish and wildlife habitat. Streams and wetlands are also economic drivers because of their key role in providing water and habitat to support fishing, hunting, agriculture and recreation. About 117 million people – one-third of the U.S. population – get some or all of their drinking water from public drinking water systems that rely in part on headwater, seasonal, or rain-dependent streams. According to the United States Environmental Protection Agency, in Flathead County: 10,788 people get some drinking water from surface water; 10,788 people get some drinking water directly or indirectly from streams that only flow seasonally or after rain or are headwaters; and 100 percent of people in Flathead County drinking surface water get at least some of their water directly or indirectly from streams that only flow seasonally or after rain or are headwaters.

Procedure

1. Discuss the field trip activities the students completed in Glacier National Park. What did students learn? What was their favorite part? Least favorite part? Did anything they did or learned at the park surprise them?
2. Explain that students will work together to examine the data they collected in the park. Why might their collected data be different from group to group?
3. Divide the class into groups of two or three students. Have them work together to complete the Webquest on pages 23-26. Each group needs to have internet access to complete the Quest.

Evaluation

Facilitate a whole group discussion by talking about the questions with check boxes (q) in the Webquest and students' answers.

Extension

Check out this [website](#) (Surf Your Watershed-Flathead Lake) to see how citizen-based groups, including middle and high school students, are at work in this watershed. You could even [Adopt Your Watershed](#) to collect water quality information, help to keep your water clean, and make a difference in your community!

Webquest

Think about the data you collected in Glacier National Park. Use your data sheet and these extra resources to complete the quest.

1st

Meet your team. Your teacher will tell you how many team members you will have.

2nd

Read through the Quest entirely. No, really, read through the whole thing so you know what information you need to collect.

3rd

Take your whole team to a computer with internet access. If some of the links have changed, you may have to search using the clues provided.

4th

Go valiantly in search of answers.



Name: _____

Date: _____

Task #1

SNOTEL (SNOW TELEmetry) is a computerized system of snowpack and climate sensors in the Western United States that gather information like snow depth, snow water equivalent, and air temperature. One of these computerized weather stations is located on Flattop Mountain in the middle of Glacier National Park. Use the link below.

Snow Station Information— Flattop Mountain

<http://www.nwrfc.noaa.gov/snow/snowplot.cgi?FTMM8>



Task #3

About 117 million people (one-third of people in the US) get some or all of their drinking water from systems that rely in part on headwater, seasonal, or rain-dependent streams. Use the link below or search for epa drinking water map. Zoom in to find Flathead County, Montana. Click the county outline.

Drinking Water Map

<http://www.epa.gov/cwa-404/geographic-information-systems-analysis-surface-drinking-water-provided-intermittent>



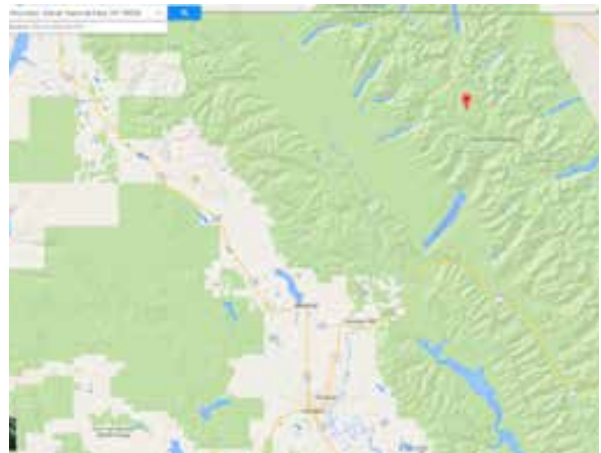
☐ How many people in Flathead County get some drinking water directly or indirectly from streams that only flow seasonally, after rain, or are headwaters? What percent of people in the county is this?

Task #4

Use the link below. Flatop Mountain will be marked with a red pointer. Zoom in or out until you see your town on the map.

Map of Glacier National Park Area

<https://www.google.com/maps/place/Flatop+Mountain,+Glacier+National+Park,+MT+59936/@48.4989734,-113.9574245,10z/Data=!4m2!3m1!1s0x5368ab16a1b687c1:0x4cd594cc556d89cc>



☐ How could the snow water equivalent in Glacier National Park effect people living in your town?

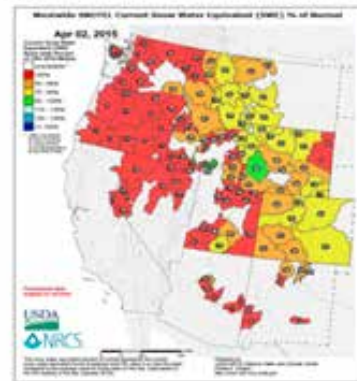
Bonus!

Use the link below or search for the Weekly Water and Climate Report website. Choose the date closest to the date of your field trip. Scroll through or search to find the [Westwide SNOTEL Current SNE % of Normal map](#). Find Flathead County.

Weekly Water and Climate Report

<http://www.wcc.nrcs.usda.gov/cgibin/water/drought/wdr.pl>

Snow



The [Westwide SNOTEL Current Snow Water Equivalent \(SNE\) % of Normal map](#) shows the largest snowpack deficits are in report territory for many basins in the Cascades and Sierra Nevada where single-digit percent of normal conditions prevail. Very low snowpacks (red areas) are reported in most of Washington, all of Oregon, Nevada, California, parts of Arizona, much of Idaho, parts of New Mexico, three basins in Wyoming, and much of Utah. Below normal snowpacks (orange and yellow areas) are also located in eastern Washington, Idaho, Utah, Colorado, most of Wyoming, Montana, one basin in central Arizona, and northern New Mexico. The snowpack in one basin in western Wyoming, one in northwest Utah, and one in southwest Idaho are near normal. There are no basins in the West reporting above average conditions.

☐ How does Flathead County's current snowpack compare to the average snowpack? Do we have more or less than average? How much more or less? _____

☐ Using what you know about how many people in Flathead County rely on streams that only flow seasonally, after rain, or are headwaters, why does it matter how much snow and water the mountains in Glacier National Park and the surrounding area are holding? _____

Extension:

Use the link below or search the Environmental Protection Agencies, "How's My Waterway?" to see how your waterway is doing. Click "Choose a Location" then type in your city and state.

How's My Waterway?

http://watersgeo.epa.gov/mywaterway/?utm_source=email&utm_medium=two&utm_campaign=watershednewsfeb26



☐ How many waterways are in your area? _____ How many of those are unpolluted? _____ Polluted? _____ Unknown? _____

How could having protected land in and around a watershed effect the quality (cleanliness) of the water? _____



Teacher Resources

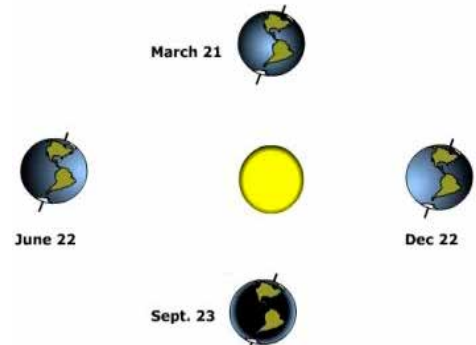
Additional Background Information



What is Winter?

Winter is the season of the longest night, the shortest day, the least light, as well as the presence of snow, cold and wind chill. It is the slowest growing season for plant life. Food supplies dwindle and it is a hard time for animals. Winter poses many challenges to plants and animals. Winter Ecologist, James Halfpenny, refers to these challenges as the **SCREW** factors: snow, cold, radiation, energy, and wind. In northern **latitudes** winter is the longest and most difficult season of the year. **Temperature**, snow depth, snow density as well as the duration of winter (a deep snow pack and late season snow extend the winter season) determine the severity of winter and play a role in how many animals survive. Many animals will die during winter. **Winterkill** refers to the combined effects of bad weather, malnutrition, starvation, disease and predation. Winter is a time for economy: food is scarce and energy must be conserved. It is truly a time of survival of the fittest.

Winter solstice (December 21) is the shortest day of the year and the day winter “officially” begins. Interestingly enough, the earth is actually closer to the sun in winter (see diagram) not further away.



What Causes Winter?

As the earth travels around the sun, different regions receive more direct sunlight than others. The tilt of the earth on its **axis** is responsible for the different **seasons** in the northern and southern **hemispheres**. In the summer, when the North Pole is tilted toward the sun, the northern hemisphere gets more direct sunlight and the days are longer than during spring, fall and winter. In winter, the tilt is away from the sun and sunlight strikes the northern hemisphere at a lower angle. Latitude is what determines both the length of the day and the angle of the sun (Waterton/Glacier International Peace Park is pretty far north and straddles the 49th parallel along the Canadian border). The amount of sunlight striking the earth's surface (**solar insolation**) and the length of the day are determined by the position of the sun in the sky. The reduced amount of winter sunlight striking the earth due to shorter days and angle of the sun causes colder temperatures. As the land and its air mass cools, surface waters turn to ice and **precipitation** freezes to cover the land with snow.

At northern latitudes and in mountainous terrain, winter comes early and stays late. At higher **elevations** the **atmosphere** is thinner and holds less warmth. Consequently, it's colder, snow lasts longer, and the length of the growing season is greatly reduced. Elevations in Glacier range from less than 3,200 feet in the Lake McDonald valley to 6,646 at Logan Pass, to more than 10,000 feet on the tallest mountains in the park. In Glacier National Park, the seasons are jokingly referred to as “June, July, August and winter.” There is some truth to this as the high country may be snow-free for only about 3 months of the year. It is not unusual to see visitors skiing at Logan Pass in June and occasionally even into July. Winter lasts a long time throughout most of the park.

It is worth noting that since the **Continental Divide** runs through the middle of Glacier National Park, the weather on the west and east sides of the park are different. The west side is

greatly influenced by Pacific Northwest weather patterns. These weather systems provide more rain, milder temperatures and (generally) moister snow than the east side receives. The east side of the park is influenced by continental weather systems characterized by less precipitation and strong, gusty winds. During winter, cold fronts moving down from Siberia and Alaska through Alberta along the **Front Range** can flow over the passes and settle in western valleys. Sub-zero temperatures can last for days or weeks. Eventually, a warm moist Pacific air mass will move in. As it moves over the mountains, the moisture condenses and precipitation occurs. The process of **condensation** releases heat that was stored in the moisture-laden air (thus the east side of the mountains is warmer than the west side at the same elevation). As this warm air moves down the east slope, it picks up speed and creates winds that can exceed 80 mph. These warm winds are known as a “**Chinooks**,” an Indian word for “snow eater.” Chinooks can cause temperatures to rise from below zero to above freezing within hours.



Snow

Snow has many different “personalities” depending upon how much water, ice, and air it contains. Snow with high water content can easily be formed into snowballs. Powder snow is so fluffy and dry that it’s nearly impossible to pack. Temperatures and wind can affect what happens to snow after it falls. It can be a light fluffy layer or it can harden into an icy surface. Snow crystals not only change as they fall through the air, but they continue to change within the snow pack over time, in a process known as **age-hardening**.

Let’s consider the water content of snow first as this is an important resource for people. Rangers in Glacier National Park have been doing Snow Surveys to measure the amount of water in the snow pack for over 80 years. Snow surveys in the West date back to the early 1900s and the Department of Agriculture’s cooperative snow survey program for predictions of meltwater runoff. This program is a federal, state, and local partnership directed by the Natural Resources Conservation Service or NRCS (<http://www.nrcs.usda.gov/feature/highlights/SnoServ.html>). To find out how much water will be available in summer, snow surveyors from NRCS and the other cooperating agencies collect data from some 1,600 snow courses several times each winter. They determine the depth and the water content of the snowpack and estimate the amount of runoff from the mountain watersheds. The information collected by the snow surveyors (and the automated telemetry system) is translated into water supply forecasts that NRCS State offices issue monthly from January to June in cooperation with the National



Weather Service. Major sectors of the Western economy- agriculture, industry, and recreation- base their plans on these forecasts. Since Triple Divide Peak in Glacier National Park divides water flowing to the Columbia River Drainage (1), Hudson Bay Drainage (2), and Missouri River Drainage (3), the amount of snow that falls here (and its cleanliness) is crucial for people living in those three watersheds.

Now let's consider how temperature affects snow and thus animals. Fallen snow is not always the same temperature. When the bottom layers of snow are much warmer than the top layers, water vapor creates a bottom or in-between layer that is granular and resembles sugar. This type of snow allows small animals like mice, voles and shrews to readily tunnel through it. Because it contains a lot of air it also is good insulating snow for grouse to hunker down in on a cold night. Animals that paw through snow like moose, deer and elk can easily uncover grasses.

But air temperatures and wind can also alter snow crystals over time to form a hard, compacted snow mass with an even temperature throughout. This type of snow is difficult for mice to burrow through. (Yet, this same snow allows snowshoe hares and deer to reach up higher in shrubs and trees in search of food.) Compacted snow such as this can cause a build-up of carbon dioxide in the lower layers as a result of decaying vegetation. Many of the small "mouse holes" seen on the surface are actually vent holes that allow carbon dioxide to escape. Without them, mice and other **subnivean** (under the snow) dwellers could die.

Why does temperature affect snow this way? Melting and refreezing changes the physical characteristics of the snow. It causes snow crystals to reshape and form a very solid layer. The strength of the snow varies, depending upon whether it is in the melt or freeze stage. Some animals can travel on the surface, while others not as well adapted, will fall through and flounder, becoming easy prey for **predators**. An icy crust allows small animals to move with ease, but may cut a deer's legs, allowing bacteria and infection to spread in an animal already in a weakened condition.

What about the depth of the snow? How does that affect wildlife? When snow gets deep, deer will **yard up** (stay in one location) since bounding through snow requires a lot of energy. Deer have such small feet in relationship to their size, they sink through snow. By yarding, they pack down a network of trails that permits them to reach areas containing winter food. At the same time, there are risks associated with it. During long, hard winters, there is the risk of **over-browsing** their winter range. And there is an increased risk of spreading diseases when many animals are confined to a relatively small area. Moose and elk can "plow" through deep snow. Moose are especially well adapted for it with their long legs. However, moose will frequently follow already established trails, while elk tend to follow in trails made by a strong lead animal. These modes of travel are known as **trailing**, and they are a means of reducing energy output. Many other animals take advantage of already established trails. Even snowshoe hares establish trails or "bunny runs" as they travel to and from their feeding areas. By using trails, winter animals can help minimize their energy output.



The depth, density and hardness of the snow can help or hinder animals depending upon the situation. A build up of snow on branches of trees may break and snap or bend young trees. Heavy snow on trees can restrict tree travel for pine martens and squirrels, making it more difficult to catch prey or to escape predators. Willows and alders bent by the weight of heavy snow provide food and shelter for snowshoe hares. Where the branches of spruce and fir catch falling snow, snow depth becomes unequal on the forest floor. In open areas snow is deeper than beneath trees. Trees with full crowns collect most of the snow on branches. The small amount that reaches the ground quickly melts or evaporates leaving a "snow shadow" or **tree well**. Many small animals avoid tree wells during the coldest part of winter since they offer little insulation or protection but if the branches are heavy enough with snow and press close enough to the ground, wind breaks are formed and tree wells become cozy hideouts for animals like snowshoe hares. As winter merges into spring, tree wells are the first places that juncos and other returning birds search for food.

How Do Organisms (living things) in Glacier Survive Winter?

Adaptations: Migration, Hibernation, Resistance (Toleration)

Organisms, or living things, all have adaptations - structures or behaviors that help them to survive in their environment. Winter ecologists classify organisms according to how they experience winter and how they have adapted to it over time. The commonly used system based on the Greek work “chion” for snow has three levels: **chionophobes**= “snow fearers” have been unable to adjust to life in the snow and are usually found in warmer regions (black vultures, palm trees); **chioneuphores**= “snow tolerators” have adjusted their life to winter and can survive but have no special adaptations (shrew, red fox, vole); **chionophiles**= “snow lovers” possess definite adaptations for life in winter and whose geographic distribution is generally limited to winter-dominated regions (spruce tree, mountain goat, snowshoe hare, ptarmigan, and weasels).

An even more basic classification system for how animals cope with winter is based on their main adaptation strategy for winter survival: **migration**, **hibernation**, or **resistance**/toleration (Marchand, 1996). Basically, living things either leave to find an area that is more suitable for them in winter (migrators) or they stay and are not active (hibernators, or organisms that have periods of torpor), or they stay and are active (resistors/tolerators). The following is generalized information about how different groups of organisms deal with winter.

Plants in Winter

By the end of summer or early autumn many plants have died back. **Annuals** will have produced seeds that have fallen to the ground and will germinate next year while the “mother” plant dies. Other seeds, housed inside plump, juicy berries will be eaten by birds, bears or other animals. Since the seeds are not digested, they will be “planted” in new locations within the droppings of these animals. The stems and leaves of **biennials** will die their first winter, but their roots will remain alive while the second year plants produce seeds to ensure survival. **Perennials** die back to the ground each year, but their roots live through winter and the plant will grow back each spring.

The leaves of **deciduous** trees and shrubs change color as daylight hours wane. Soon the leaves will be shed. Lowered temperatures will retard plant growth. **Leaf scars** are sealed with a corky layer and next year’s **buds** are covered with scales to conserve moisture. Winter is similar to drought as water is unavailable when it is frozen as ice or snow. Woody shrubs and trees survive the winter in a state of **dormancy**. Evergreen trees and shrubs have thin or small needle-like leaves with waxy coatings to conserve moisture.

The conical shape of many **evergreen** trees makes them more resilient to heavy snow loads. Since their branches slope out and downward, the weight of snow pressing down allows snow to fall off. If enough snow falls from the branches it can pull the branches until they touch the ground and make a wall of snow and branches around the base of the tree. These tree wells can become shelter for wildlife out of the wind. Evergreen trees will photosynthesize at the first available light in spring.



Insects in Winter

Just as many plants go through a resting phase in winter, many insects time their particular life cycle stage best suited to withstand cold, drought-like conditions and lack of food. During this time, activities and/or development discontinue until conditions become favorable in spring. Individual species of insects overwinter at different stages of their metamorphosis.

Insects comprise the base of the food chain and the absence or presence of their populations has a large effect on food availability for other organisms. Chickadees feed largely on insects and have the ability to hang upside down on branches to look for insects hiding on the undersides of leaves and branches. It is interesting to think about what happens to insects, an important food source in winter.



Douglas Fir Beetle Larvae in Gallery

Insects that have incomplete metamorphosis (egg, nymph and adult) usually overwinter in the egg stage. For insects that develop through complete metamorphosis (egg, larva, pupa and adult), the egg and pupa are the most likely stages for overwintering since they are immobile and they have a protective

coating that helps them withstand

Woolly Bear Caterpillar (larval stage)



the cold. But some insects like the woolly bear caterpillar overwinter as a larva. The woolly bear stops eating in late summer and finds a sheltered place under leaves and grass. In spring, it forms a cocoon and emerges as an Isabella moth.

Insects that overwinter as adults usually find a sheltered place: under leaves, in crevices in trees, under bark, rocks, plants, in buildings, or they descend into the ground and remain dormant. Staggered timing of life cycles ensures that food will be available when they reach the eating stage. Insects react to cold temperatures by slow, stiff movements and a lowered metabolic rate. They lose a high percentage of water and produce glycol, a substance that acts as a kind of antifreeze. We think of these organisms as hibernating to avoid winter, but they actually have complex strategies to resist severe cold stress. On warm days adult insects move around as their bodies warm up sufficiently. The table on the next page lists some of the common insects and their overwintering strategies.

How and Where Some Insects Over-Winter

Insect	Species	Overwintering Stage	Special Preparation	Active or Inactive	Where?
Ants	Carpenter	Adult	Produce glycerol	Inactive	In trees or logs
Aphids	Most	Egg	None	Inactive	In bark crevices or base of twigs
Bumblebees		Queen	Pre-fertilized eggs inside queen	Inactive	Underground, under leaves or logs
Butterflies	Monarch	Adult	Migrate	Semi-active	Mexico or CA
Butterflies	Painted Lady	Adult	Lose body moisture	Inactive	Under bark
Butterflies	Swallow-tails	Pupa	Form chrysalis	Inactive	Attached to stems or on the ground
Crickets	Most	Egg		Inactive	In the ground
Dragonflies	Some	Egg		Inactive	On the bottom of a pond
Dragonflies	Some	Nymph		Semi-active	On the bottom of a pond
Flies	Cluster & House flies	Adult		Inactive except when warm	In crevices of buildings or cracks in hollow trees
Grasshoppers	Most	Egg		Inactive	In the ground
Beetles		Larva (grubs)		Inactive	In the ground
Honeybees		Adult	Store food	Semi-active	Hive in a tree or man-made box
Ladybug	All	Adult	Cluster together	Inactive	Under leaves and grasses

Galls

Galls form when insects lay their eggs on plants. A swollen lump on the stem or leaf of a plant may be a gall. Galls can be a variety of sizes, shapes, and colors, some up to the size of a baseball! Most galls form on plant leaves but they can also form on branches, twigs, buds, flowers, fruits, and even roots. Some insects lay their eggs on the plant surface and others make a hole in the plant and insert their eggs inside. Not everything is known about gall formation but in response to the egg-laying, the plant either produces new cells or enlarges existing cells around the area. The newly formed gall provides some protection to the insect eggs (and larvae when they hatch) from the sun, wind, rain, and predators, but not fool proof. There are other insects that invade galls looking for food. Winter is a good time to look for galls since there are fewer leaves on plants.

Animals in Winter

Hibernation

Animals that spend the winter in Glacier National Park are either active or dormant. Dormancy ranges from short periods (**torpor**) to long periods (**hibernation**). Skunks and badgers, for instance may undergo periods of torpor as an energy saving measure during times of extremely cold weather. Hibernators generally sleep through the winter although they may awaken and move around. Hibernation can be defined as a physical state where an animal's body functions slow down in order to conserve energy through a season of no food and water, and cold temperatures. The extent to which the metabolism slows in order to be considered a "true hibernator" is debatable. Hibernators such as Columbian ground squirrels and marmots have drastically reduced body temperatures. A ground squirrel's temperature may drop to 39 degrees Fahrenheit compared to its usual 90 degrees Fahrenheit temperature. Reduced temperatures slow other processes so pulse and respiration rates drop. Breathing may be once every 4 to 6 minutes. At this slow pace, a minimum of energy is expended and the animal's fat layers can usually meet their slight demand. Many hibernators also curl up into a ball to conserve heat. Ground squirrels and marmots therefore, are considered "true hibernators."

Whether animals, like bears and chipmunks, hibernate or not depends on your source and definitions. Living things do not follow definitive rules. Thus, there is a continuum between the "true hibernation" of ground squirrels and marmots in which all bodily functions are greatly slowed, the deep sleep of bears and chipmunks, and the occasional sleep of raccoons and gray squirrels. Hibernation is the extreme end of the continuum. Bears are said to not truly hibernate because although their bodily processes are slowed, they do not have the reduced body temperatures of other "true hibernators." But bears develop thick coats of fur and have less surface to mass ratios than smaller hibernators so they stay warmer. Bears' metabolism drops by half and their digestive system tightens into a knot, with the limited waste products reprocessed into the bloodstream in the form of proteins. Bears, if not true hibernators, are certainly close. Bears sleep for months without eating, drinking, urinating or defecating. It has been said that while bears may not be true hibernators, they are "digestive hibernators."

Migration

When we think of migration, we generally think of birds. Some of the birds that spend summers in Glacier may fly hundreds or even thousands of miles to their wintering area. As birds migrate to warmer climates, they alter their food source and wait for spring or summer to return to their home territory. These amazing migratory treks vary in length; some may span the length of the globe. **Day length** is believed to be the major factor in telling birds it's time to move on. Winter in Glacier National Park is difficult. The food supply has diminished, the length of day and the time in which to locate food is reduced and the amount of energy needed to stay warm is increased.

While 92 birds are listed as common residents of Glacier in summer, only 28 birds are listed as common winter residents (see Glacier National Park Bird Field Check List 1990 in reference section). The Clark's Nutcracker is an example of a bird that migrates from its summer home up in the mountains to lower elevations during winter.

Cold, wind, and blowing snow of the high country offer challenges greater than most animals can adequately cope with. For animals that remain active during winter, lower elevations offer easier access to food and more protec-



tion from the elements. Animals that move from areas of higher elevations to those that are lower with less snow and more food are considered “altitudinal migrators.” Elk and mule deer are two other examples of animals that move from higher elevations in summer to lower elevations in winter.



Clark's Nutcracker

While migration may seem like an easy option, it places a major strain on these animals. Huge energy reserves are required to make these seasonal journeys and migrators often face competition with native species once they arrive at their wintering site.

Resistance (or Tolerant)

To many animals, winter means staying and enduring the challenges of the season and resisting its stresses. Because many organisms cannot simply flee from the cold Glacier winters, they have found numerous ways to survive the harsh climate. There are many fascinating adaptations in the animal world that help them resist winter's hardships.

Birds that resist winter stresses have numerous techniques for survival. When temperatures drop, birds will fluff out their feathers. Feathers are good **insulators**, and fluffed out feathers create a thick layer of stable air around the body. Many small birds **huddle** together at night to reduce heat loss. Others **roost** in tree cavities. Grouse hunker down in deep snow on cold nights, and a scaly projection on their toes helps them to walk on snow. Some birds, including grouse, will store large quantities of food in their **crops** late in the day to carry them through cold winter nights. Gray jays are known to store food on branches of trees or on the ground. Chickadees have an amazing ability to hang upside down on branches as they search for insects. This maneuver allows them to locate food when the upper surface of branches is snow covered. And woodpeckers continue to feed on insects deep within trees.



High in the alpine, the pika will remain active all winter in its den hidden among rockslides. It will feed on “hay” made up of grass that was cut, dried and stored during summer. It has distinctive adaptations that allow it to survive the long and extreme winter conditions. Its small round ears lay flat along its head; an inconspicuous tail and short legs reduce surface exposure and heat loss; and fur insulates the soles of its feet and provide good traction. Pikas may look like rodents but they are related to rabbits.



Pika

Mountain goats are the largest mammals remaining active in the high country year-round. Their heavy wool **undercoats** and long hollow **guard hairs** provide protection from the cold and wind. Mountain goats can subsist on **lichens** and **mosses** if they cannot find adequate browse. In winter goats move to more south or southwest facing slopes where the winter sun melts snow more quickly and prevailing winds blow the snow away, exposing lichens and vegetation.

The Ptarmigan is the only bird that remains at or above treeline throughout the winter. This alpine cousin to the grouse changes its brown plumage to white as autumn light diminishes and winter snow begins to blanket the mountains. Feathered feet act as snowshoes which allow it to walk on snow. Sharp claws help it to scratch for food beneath the snow. Ptarmigan will feed on willow buds and the needles of subalpine fir. Warmth and protection from winds and sub-zero temperatures is attained by diving into the snow.

Prior to the actual onset of winter, animals that resist winter stresses have physiological responses that are cued in by the reduced daylight hours. Less daylight trigger a response that is registered in the “master control” gland (**hypothalamus**) in the brain. The hypothalamus then secretes **hormones** that activate other systems throughout the animal’s body. Animals react in various ways. Moose, elk and deer begin to **rut**. The interval between the mating season and giving birth ensures the young will be born in the spring when food is abundant. Another reaction to shorter days is the urge to eat more thus building up layers of fat that will help animals make it through winter. Beavers and red squirrels **cache** extra food. Animals that remain active all winter will grow a thicker coat of fur. Deer, elk and moose have **winter coats** comprised of hollow hairs that trap air for better insulation. Other animals develop thick **undercoats**.

Snowshoe hares, weasels and ptarmigan in Glacier National Park turn white. The absence of the pigment melanin, means there are more air spaces within the hairs and thus it has greater insulation value. Snowshoe hares’ white winter pelage has 27% better insulative qualities than the summer brown coat (www.bobpickett.org/winter_adaptations.htm). **Photoperiod** triggers hormonal changes that are also influenced by cold and snow. These hormones cause changes in hair color. Weasels undergo a complete molt. Each hair is lost and a new white hair replaces it. Only the tip of the hair turns white on snowshoe hares, while the base remains gray. Timing is critical. A white snowshoe hare or weasel (ermine) makes an easy-to-spot target for a predator. Snowshoe hares as their name implies, have snowshoes: extra fur on the bottom of their large feet in winter helps distribute their weight so they can move on top of the snow with ease.

For animals that remain active in winter, snow is a mixed blessing. It can offer shelter and protection. Snow acts as insulation, holding in earth-warmed air and keeping out cold air. Snow creates a stable environment beneath it (**subnivean** layer) in which temperatures may range from about 20 degrees Fahrenheit to 30 degrees (F), while air temperatures can fluctuate from 30 degrees (F) below zero to 45 degrees (F) above zero. The subnivean world allows plants, insects and animals to escape from temperature extremes and wind. This is important for small animals like mice, voles and shrews. Since their body surface is large in proportion to their size, they lose heat rapidly and it takes considerable time (and energy) to replace it. Their small size does not allow them to carry a thick enough coat to withstand continual exposure to cold. The bark of trees and shrubs, seedheads from plants flattened by snow, and leaf litter/detritus provide much of the food for these small insects and animals. The tracks of mice, voles, and shrews indicate they do spend time on top of the snow (**supranivean** layer) in search of food but these forays can make them vulnerable to predators.

Humans in Winter

Although humans today do not have the capability of hibernating like bears or marmots, we are able to migrate or resist. Native Americans had many strategies for dealing with winter. They built shelters to protect themselves from the cold and wind. They had elaborate systems for obtaining and making warm clothing and for caching and storing food to last throughout the winter. They changed their behavior in winter to conserve energy. Some groups followed seasonal animal migrations in order to have access to more food or shelter from the wind during the winter months. Today, humans are still building shelters to protect ourselves from the cold. Modern clothing can still be found made of animal furs, feathers (down) and plants (wool and cotton), but also from materials like polypropylene or capilene. The infamous “snow birds” from the northern states (and Canada) move in droves in December to warmer climates and remain there until the end of winter.

Snowshoes

The use of snowshoes dates back over a long period of human history. Archaeologists estimate that the first “foot-extenders” used for easier snow travel originated in Asia about 6,000 years ago. Eskimos living in arctic regions did not require the use of snowshoes since most of their travel occurred on wind packed snow or on sea ice. For Native Americans living in forested temperate areas, snowshoes were a necessity for getting around in the winter. The Athabascan Indians of the American and Canadian west coast and the Algonquin Indians of the Ottawa and St. Lawrence River valley areas brought the snowshoes to perfection. Before horses were introduced to America by the Spaniards, the Plains Indians used snowshoes to hunt buffalo.

During the period of westward expansion, snowshoes were just as important as the axe and flintlock rifle in areas where snow was deep throughout winter. Trappers, hunter, explores and surveyors in these areas couldn’t be without them. Perhaps the first snowshoes came about when someone watched how easily the snowshoe hare and lynx could travel across the surface of the snow. These animals have very large feet in relation to their body size. Bigger feet allow an animal to spread its weight over a larger surface area (less weight per square inch) which helps to keep it on top of the snow.



Snowshoes are just one of the technological innovations that humans have developed over time to help them to survive winter. By observing and learning how other organisms cope with winter stresses, humans have been able to continue to develop new techniques and strategies to make our lives easier in northern climates. It will be intriguing to see the discoveries and changes that happen in the next century as more information on the interrelationships between living things and their winter environment come to light.